

## DOCUMENT RESUME

ED 166 046

IE 008 438

AUTHOR David, A., Ed.: And Others  
TITLE Engineer's Needs for Scientific and Technical Information.  
INSTITUTION World Federation of Engineering Organizations, London (England). Committee on Engineering Information.  
SPONS AGENCY United Nations Educational, Scientific, and Cultural Organization, Paris (France).  
PUB DATE 79  
NOTE 52p.: Contains some light print.  
AVAILABLE FROM Secretariat of WFEO/CEI, Hungarian Federation of Technical and Scientific Societies, H-1055, Kossuth Lajos ter 4/6, Budapest, Hungary.

EDRS PRICE MF01/PC03 Plus Postage.  
DESCRIPTORS \*Developing Nations; Engineering; \*Engineering Education; \*Engineers; Global Approach; \*Information Needs; Information Retrieval; \*Information Utilization.  
IDENTIFIERS \*Scientific and Technical Information

## ABSTRACT

This study has as its main object the formulation of an approach, as global and comprehensive as possible, to the multiple aspects of the engineer's needs for scientific and technical information. The basis of the study is an analysis of the engineer's role, its characteristics, different specialties, levels of training, and categories of functions within the profession, and a typology of information necessary for the engineer is drawn up from this standpoint. This broad evaluation leads to an investigation of methodology. Presently there is a lack of knowledge and consensus in this area which necessitates further study. An analysis of the engineer's information requirements raises three fundamental questions. The first concerns whether in fact the present classification of scientific and technical information is in harmony with the engineer's work, and whether it permits him to obtain the information he needs. The second problem relates to the training of the engineer in the utilization of present and future information means, particularly computers. The third concerns the adaptation of these considerations to third world countries. The study concludes with a synthesis in question form to provide a confrontation of different viewpoints and experiences and allow a choice of possible new studies. (Author/RAA)

\*\*\*\*\*  
\* Reproductions supplied by EDRS are the best that can be made \*  
\* from the original document. \*  
\*\*\*\*\*

ED186046

WORLD FEDERATION OF ENGINEERING ORGANIZATIONS  
COMMITTEE ON ENGINEERING INFORMATION

U.S. DEPARTMENT OF HEALTH,  
EDUCATION & WELFARE  
NATIONAL INSTITUTE OF  
EDUCATION



THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

ENGINEER'S NEEDS  
FOR  
SCIENTIFIC AND TECHNICAL INFORMATION

"PERMISSION TO REPRODUCE THIS  
MATERIAL HAS BEEN GRANTED BY

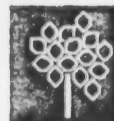
P. Lázár

TO THE EDUCATIONAL RESOURCES  
INFORMATION CENTER (ERIC)."

PARIS  
1979

1-2008438

WFEO|FMIOI



The manuscript has been prepared, under a contract with Unesco, by

Mrs. A.DAVID /France/,  
Mr. J.E.CREPS Jr. /USA/,  
Mr. M.MILED /Tunisia/,  
Mr. W.PIRÓG /Poland/,

edited by

Mrs. A.DAVID /France/,

members of the Committee on Engineering Information of the World Federation of Engineering Organizations /WFEO/CEI/, under the Direction of P.LÁZÁR, Chairman of the Committee and

printed by the

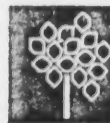
WFEO Secretariat /Paris/ and the

Hungarian Central Technical Library and Documentation Centre /Budapest/.

1st print: October 1979

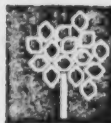
2nd print: January 1980

## WFEO|FMOI



## S U M M A R Y

|                                                                                                                                                                                                                       | Page |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| I - Introduction                                                                                                                                                                                                      | 1    |
| II - Engineers as information users for their professions                                                                                                                                                             | 4    |
| III - Classification of the Information needed by the Engineers                                                                                                                                                       | 8    |
| IV - Determining the information needs of engineers - Methodology                                                                                                                                                     | 17   |
| V - STI Evolution - Its role in engineer's work                                                                                                                                                                       | 25   |
| VI - The Education and Training of engineers in the use of information banks                                                                                                                                          | 30   |
| VII - Specific problems of information need of engineers in developing countries                                                                                                                                      | 37   |
| VIII - Conclusion                                                                                                                                                                                                     | 42   |
| <u>Appendix:</u> - References                                                                                                                                                                                         | 43   |
| - International Conference on National and Regional Planning for Scientific and Technological Information Systems and Services for development in the Arab Countries - Tunis, April 1976 - Conference Recommendations | 45   |

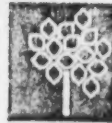


## I - INTRODUCTION

- 1) The study of engineering information requirements has been the focus of activities of the WFEO/CEI Engineering Information Committee as of its creation. Across a diverse range of activities - studies, work groups, conferences and seminars, enquiries, ... - and according to reflections voiced by its members, this committee has endeavoured to specify certain recommendations concerning the realisation of those means of information best capable of serving the world engineering community.

These recommendations have been formulated with a view to the interest of governments as well as that of the international organizations with which WFEO enjoys privileged standing (UNESCO/UNISIST, UNIDO).

- a) at UNISIST, in 1975 : it was recommended that one take into account the particular characteristics of industrial information in training the future charges of technical information centres ; and that an effort be made to foresee liaison means, making possible the diffusion of technical information as well as the total of useful engineering data. It was recommended that a methodology be developed for analysing requirements and for inciting government authorities to realize means of information corresponding to the need and plans of industrial development.
- b) at United Nations, in 1976 : as regards the project of creating a world bank of industrial information, the recommendations forwarded, based on the work of an ad hoc WFEO/CEI group, had particular bearing on :
  - the necessity to take into account the variety of information sources useful to the engineer,
  - the necessity to adapt the information supplied to the end envisaged,
  - the necessity of there being a human intermediary to make information available to engineers.
- c) at the CASTARAB conference in Rabat, in 1976, were forwarded the Tunis conference recommendations concerning : "The planning and regional development of systems of scientific and technical information in the Arab countries (April 1976)". These recommendations were adopted by the Arab Ministries of Science and Technology (cf. appendix II).



- 2) The present study, basing itself on existing works (cf. appendix I) and especially on those of WFEO/CNEI, has as its main object the formulation of an approach, global and as comprehensive as possible, to the multiple aspects of engineers' information needs.

It does not pretend to be able to furnish "The Solution" to the problem of satisfying such needs; in effect, such an undertaking, albeit tempting, a priori, would be ambitious if not utopian.

Tempting, in that this problem is common to all countries. To study it in an international context with the directly concerned party - that is the engineers themselves - is certainly a positive move. Tempting also because the exchange of information between countries is one of the aids to technical, industrial and economic development, which constitutes one of the sacred missions of the Engineer in any society.

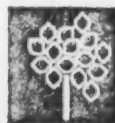
Ambitious because there is no such thing as a universal type of engineer ; neither is there a clear and non-ambiguous definition of the expression "professional activity". And yet the necessary or desired information is first and foremost tied up with this activity of the engineer.

Lastly, we use the work "utopia" because there exists already a wealth of reflection on this subject and despite progress in technical means of communication, in the science of information and of associated technology, it does not seem that the engineer is truly satisfied with current alternatives.

- 3) The information he requires is of course a function of his professional activities. For this reason, the current study is based on an analysis of the engineer's role. We have examined the characteristics, the different specialities, the levels of training, and the categories of functions carried out within this profession. Hence, chapter II concerns this analysis, which then enables us to discern more clearly what information is in fact useful to the engineer, with relation to his various activities.

From this standpoint and using as guidelines the results of various enquiries, we have attempted, in chapter III, to draw up a typology of information necessary for the engineer. This very broad evaluation leads to the investigation of a methodology. In chapter IV, we have demonstrated the inadequacy of our knowledge, as well as the lack of general consensus as regards this question, thus emphasizing the factors which necessitate a complementary study. Furthermore, such an analysis of the engineer's information requirements raises the following three fundamental problems :

## WFEO|FMOI



- The first of these is the question of determining whether the evolution in the classification of scientific and technical information is in fact in harmony with the engineer's work, and consequently whether current means of information in fact permit him to obtain that which is necessary to him. Framing and clarifying this question according to existing works, we have shown, in chapter V, the need for a precise study so as to realize this equity.
- The second problem that arises concerns training the engineer in the utilisation of present and future information means, and particularly in the use of computerized sources. Chapter VI is thus concerned with the conditions of training; these being analagous to studies in the recent UNESCO/UNISIST manual, in which CEI/WFEO were collaborators, and which is entitled "Education and Training of Users of Scientific and Technical Information". In this case also, there is as yet no set guide-line, nor a recognized methodology, as basic frame of reference. We have endeavoured, in presenting training conditions of the engineer, to outline a methodological study.
- The third problem concerns the adaptation of these considerations to developing countries. For such countries, characterized by their youthfulness and by the youthfulness of their industrial efforts, what constitute the priorities in their information requirements, what are the essential means to be established, the barriers to utilisation and development of these services, and lastly, what are the training possibilities for the users of information services ? In chapter VII, we outline very broadly the aspects of this problem, so as to provide a framework for discussion or for a future study.

In conclusion, we have attempted to draw up our synthesis - which we have made as broad as possible - in question form, so as to enable the confrontation of differing view points and experiences and a choice of possible new studies ; thus the realisation or development of means of information that are adapted to the engineer's requirements.



## II - ENGINEERS AS INFORMATION USERS FOR THEIR PROFESSIONS

### What is an engineer ?

The term "engineer" has not up to date univocal, general definition. There exist various descriptions of this term. Among others, this of the conference of representants of engineers associations of European countries and the United States of America formulated in 1958 :

"An engineer basing on his profound education and professional practice is able to apply scientific methods and scientific point of view for analysis and solution of technical problems. He is able to undertake responsibility for development and application of science and engineering knowledge in researches, production, management and engineers training. An engineer ought to be able to decide by himself on technical problems and he should be responsible for management within his speciality".

With an "engineers" notion is connected a creativeness and development, production of new material goods and values for satisfying of societies need, ability of practical use for the human needs of discovered laws of nature in order to make easier the human life. It is also linked with ability of joining various phenomena and questions to solve the problems.

Specially interesting is to emphasize that it is very important to use by an engineer his practical experience. It is particularly important in the cases when appear problems, which are not fully recognized. Then, a great role plays experience and intuition, which is based hitherto on grounded subconsciousness and experiences. Intuition helps an engineer to undertake decision

According to the meaning of the above mentioned definition, the aim of engineers activity is achievement of a use value of his work effects within conditions of existing reality.

In the last years appeared the new criteria for work and activity of engineers. There was shown that not only the best technical solutions and products features, their prices and utility, the most economical, technological solutions have value. It is not possible to use more and more sophisticated technology and technics without taking into consideration influences, which are destructive for natural environment. The social responsibility, in this field, is based on engineers.

# WFEO|FMOI



In recapitulation, the silhouette of engineer could be characterized, as follows :

"Engineer is a person with invention straining after the progress improving non stop his activity, means and methods of work and production and creating the new material goods and values. Engineer should possess four groups of features : knowledge, ability, individual qualifications and ethics. Engineer's knowledge should comprise the fundamental sciences / mathematics, physics, chemistry, branch technical sciences and elements of social and economic sciences. Ability concerns skill how to use and reach new knowledge the way of creativeness, undertaking decisions, professional mobility and work in groups and their management. Individual features are : undertaking of decision, risk and responsibility and initiative, persistence and overcoming difficulties, common sense and culture. In the group of ethics should be mentioned : feeling of high engineer's social position, friendly contacts with people and high ethics" (1).

The presented silhouette of engineer concerns his features independent of his speciality and work range.

## Kinds of Engineering Specialities

Amount of engineering specialities is different in various countries. In some highly developed countries, the amount of engineering specialities exceeds the number of 150. The amount of engineering specialities is continually increasing. There are two reasons : development of existing branches, within which arise new specialities with a more profound thematic range and need of engineering activity within new thematic range.

To the traditional engineering specialities belong, for example : mechanical engineer, electrical engineer, chemist, civil engineer, architect, geologist, geodesist, mining engineer, engineer hydrotechnician, air engineer, textile engineer, metallurgist, casting engineer, shipbuilder, agronomist, forestry engineer, etc... In particular, technical branches as result of their development and appearance of more and more new problems, arose the need of specialists, in various activity range within a special branch. For example, there are specialists within mechanics : mechanical engineer - technologist, mechanical engineer - constructor, mechanical engineer - specialist in production organization. There are following specialists in the field of electro technology : electrical engineer, power engineer, electronics specialist, radio engineer.

(1) Tymowshi J., Characterization of engineers and his profession, Report NOT, Warsaw, 1979.



### Kinds of Engineering Degrees

There are various kinds of engineer's degree, certified by diploma from high schools.

These degrees are obtained at high school on academical level or at high, not academical, schools. In various countries, there is different amount of engineering degrees characterizing the level of engineering education. Mostly, there are two engineer degrees :

- master in engineering science / dipl. engineer /
- bachelor of science in engineering / professional engineer /

Education programme of the first group of engineers has more theoretical items. The programme of the second group is more practical. In some countries, there is a level in the middle of engineer and technician. Such a specialist is called technologist. This group of workers has direct contact with engineers.

### Kinds of Engineering Functions and Posts

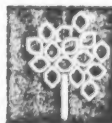
Engineers within their specialities are employed in various organizations, on various posts and fulfill various functions. The main organizations employing engineers are scientific and research institutes, development centres, design offices, consulting services, laboratories, factories and industrial plants, building companies, trade and traffic enterprises, education and training institutions, public administration, scientific and technical libraries and information centres.

The main subject matter of engineer's employment is : scientific researches, development works, designing of new products, technological processes and investment objects, management, organization and control of production and exploitation processes sale and supply, teaching and technical-administrative works.

Functions of engineers may be divided into following leading categories :

- Management - responsible for decision making on matters of an engineering nature ;
- Research - searching for a new knowledge and teaching at advanced levels ;
- Design and development - planning and creating new products, systems, buildings, ... ;
- Education - training of engineers and technicians ;
- Operations - process control for the production and products ;
- Technical support - materials supply, site maintenance, and other services of a para-professional nature (f.e sales, investment services).

# WFEO|FMOI



Within above enumerated categories may be put other functions by analogy, f.e consulting function, which demands qualification as function of design and development.

It is to be mentioned that one person will frequently perform more than one single function and that, in this case, his function needs will vary according to the function being performed.

The engineers usually occupy the following posts :

- Within management, director and deputy director in industrial and economic organisations, manager and assistant manager of particular departments in those organisations.
- Within scientific and research institutions - in management of those institutions and as leader of scientific works and as scientific workers, and also as technical personnel on the higher level.
- Within design offices and laboratories, the engineers occupy posts of managers, designers and constructors as well as leader of projecting teams.
- Within industrial plants and factories, the engineers work as managers, heads of departments / e.g. organization of production technology, technical control, means for production /.
- Within sales and supply organizations, the engineers are employed as managers, branch specialists, trade-technical representants, etc...
- Within building companies, the engineers occupy the posts of managers, department heads, clerks of the building works, directors of territorial branches and supervisors of the building works.
- Within traffic enterprises, the engineers work as managers and directors and also occupy various leading posts.
- Within education and training, the engineers are employed as head of schools, scientific and didactic workers.
- In scientific and technical libraries and information centres, they are employed as directors, librarians, information officers.



### III - CLASSIFICATION OF THE INFORMATION NEEDED BY THE ENGINEERS

According to the definition of WFEO/CEI, engineering information is that information which is used, needed, or generated by engineers in the practice of their profession. While the major part of such information is scientific or technical in nature, progress has spread so far that other kinds of information such as economic, marketing, commercial, social, managerial and legal information have to be taken in consideration.

In many cases, information that is needed by engineers is both location and time dependent. For example, engineering standards differ from country to country : product specification data changes rapidly with new technological advances ; and laws and regulations which affect engineering practice vary from country to country, and can be subject to frequent change.

So as to establish a typology of information useful to the engineer, we have taken in account the following parameters, each of which characterizes a specific information need : object, geographic source, origin, properties, users' attitude.

#### 1 - Subject matter

According to different papers and inquiries, the subject matter of information for engineer is following :

- Information on industrial equipment, machinery and tools comprising :
  - . equipment and tools for professional activity / e.g. equipment for craftsmen, medical equipment, etc... /,
  - . equipment and machines for production of other products, equipment and machines for building, for agriculture, for special functions in social life, etc... /e.g. equipment and machines in factories, means and equipment for transport and communication, technical equipment in the cultural posts, etc.../,
 technological and technical-economic data / exploitation costs, efficiency, purchase prices /.
- Information on raw materials, semi-finished goods, their features, application field and substitution possibilities.
- Information on products serving an immediate consumption. Such information is the object of interest for improving the features of goods, the processes of their production.
- Market information - in the broadest possible sense - domestic and foreign markets, including demand for goods, duties, tariffs and other market restrictions, prices, availability of transport and distributions schemes, etc...

# WFEO|FMOI



- Technological infrastructural information on terrain, especially important as regards localization of new enterprises.
- Information on labour market, labour situation, employment and training opportunities, wages /cost of labour/, social insurances, availability of highly qualified personnel.
- Information on the industrial environment, services, research facilities, industrial legislation on patents and licensing, industrial chambers and associations, inquiry and extension services, export promotion, etc...
- Information on existing industrial enterprises, their potential, organization, equipment, applied technologies, trade, production costs, etc...
- Information on industrial authorities, planning institutions and institutions acting in the field of industry.
- Information on information centres.

## 2 - Geographic source

80 % of utilized information come from the country of the user.

## 3 - Sources of Engineering Information

The sources of Engineering information are the following ones :

- Books in the field of science and technology are the traditional information sources. Some of the books as monographies, manuals, encyclopaedias, technical calendars and technical guides, represent the value in engineer's work and they can be evaluated as an important tool by calculations, construction designing, by technical and economical analysis.
- Scientific and technical periodicals. They provide information in short time, are easy to use by users and they can be suited to the actual needs of the users, as also they spread some new ideas.
- Reports on scientific researches are of great worth information sources, because they comprise information on carried out and finished research works.
- Preprints and proceedings of scientific technical conferences, congresses, symposia, seminars. These materials contain the most actual information in the given field.
- Standards contain information on features and qualities of products, technology of production, treatment methods, research and measurement methods.
- Patent literature. Patent description is a specially valuable information source, because it gives new solutions, which can be used for practical needs and aims.

# WFEO|FMOI



- Firm literature. The firm literature contains publications and documents prepared and issued by interested in these firms and publication concerning manufacturers and suppliers prepared and issued by institutions and organizations just above mentioned. Most often, the publications and documents appear in the following forms : catalogues and prospectus of products, price-lists, periodicals, guides, handbooks, publicity publications /placards and leaflets and various occasional issues/. These publications and documents are mostly richly illustrated. The catalogues contain the tables with technical and economical data.

The most popular form of firm literature are catalogues and prospectus. There are two kinds of these issues :

- . trade and publicity catalogues and prospectus,
- . technical catalogues and prospectus.

The first of them has the following features : large scale character, irregularity, inequality of publishing forms, very often incompleteness of data, indication of positive features, the limited data of technological and construction matters. They are very communicative for a customer and very easy obtainable. Considering not full objectiveness, this kind of publication is used with some apprehension.

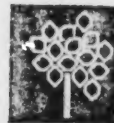
The technical catalogues are the precious information source, because they contain the exact technical and economical data of products. As a rule, they are designed for a special group of customers or potential customers, and for own personnel as also representatives of firm.

The price-lists contain mostly a general characterization and the most general data of products as also they give prices and conditions of supply.

The firms considerably often issue the occasional publications in which they characterize the potential of firm, field of production and list of more important supplies and services worked out for customers.

- Trade literature and scientific technical periodicals publishing the papers on products and advertisements of industrial firms.
- Reports of engineers on visiting other institutions. This information reflects the technical level and production organization in visited factories which can be used in their mother institutions.
- Projects documentation contains valuable information on the applied solutions
- The scientific technical films. Similarly, as reports on the above mentioned visits, the scientific technical films can include an interesting information applied in a given enterprise.
- Home documents of institutions concerning various problems.
- Participation in conferences, symposia and others offers the engineers possibilities of personal contacts which sometimes are available in other way.

## WFEO|FMOI



- Visiting of exhibitions and trade fairs. They give the possibility to acquaint with the existing world solutions of machinery and equipment.
- Exchange of personal experience. From all enquiries, it is the most used information source. The reasons are : feasibility, accessibility, simplicity.

These sources are differently used according to users and countries. Here are some examples resulting from enquiries in U.K., Poland, Soviet Union.

Table 1

| INFORMATION SOURCES                                                                                                                                                 | USERS                                                   |                             |                  |                            |          |                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------|------------------|----------------------------|----------|-------------------------------------------------------------------------|
|                                                                                                                                                                     | Res.eng.<br>on machi-<br>nery and<br>equ. de-<br>velop. | Eng. in<br>test.<br>station | Con-<br>structor | Eng. in<br>produc-<br>tion | Designer | Engineer<br>techn.<br>head                                              |
| Books, handbooks, standards                                                                                                                                         | 20                                                      | 20                          | 10               | 10                         | 10       | uses<br>chiefly<br>properly<br>selected<br>seconda-<br>ry docu-<br>ment |
| Periodicals                                                                                                                                                         | 20                                                      | 10                          | 10               | 10                         | 10       |                                                                         |
| Difficult available sources<br>/e.g. reports/                                                                                                                       | 10                                                      | 5                           | 0                | 0                          | 5        |                                                                         |
| Patent literature                                                                                                                                                   | 10                                                      | 5                           | 10               | 0                          | 5        |                                                                         |
| Mother information of company<br>/research resul. travelling<br>reports, montage rep., reports<br>on techn. state and damages in<br>establish., technological rules | 20                                                      | 20                          | 30               | 30                         | 30       |                                                                         |
| Information from conferences,<br>fairs and professional visits                                                                                                      | 10                                                      | 10                          | 10               | 20                         | 10       |                                                                         |
| Prospectus information and<br>materials from suppliers of<br>competitive firms ; information<br>of representants of other firms                                     | 10                                                      | 30                          | 30               | 30                         | 40       |                                                                         |

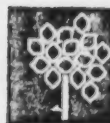
Evaluation of various information sources  
in machinery industry in FRG / 1960



Table 2

| The most useful<br>information sources                          | Chemists               |                        | Physicists             |                        |
|-----------------------------------------------------------------|------------------------|------------------------|------------------------|------------------------|
|                                                                 | Participation in %     |                        |                        |                        |
|                                                                 | Special<br>information | Current<br>information | Special<br>information | Current<br>information |
| Patents                                                         | 6 - 15                 | 6 - 15                 | 0 - 5                  | 6 - 5                  |
| Reports on scientific<br>researches of governmen-<br>tal bodies | 0 - 5                  | 0 - 5                  | 6 - 15                 | 6 - 15                 |
| Abstracts                                                       | 56 - 65                | 45 - 55                | 23 - 35                | 36 - 45                |
| Personal contacts                                               | 36 - 55                | 26 - 35                | 56 - 65                | 36 - 45                |
| Conferences and meetings                                        | 6 - 15                 | 46 - 55                | 16 - 25                | 36 - 65                |
| Reviews                                                         | 26 - 45                | 56 - 75                | 16 - 75                | 36 - 65                |
| Primary documents                                               | 56 - 65                | 36 - 45                | 56 - 65                | 34 - 45                |
| Library /Infor.<br>department/                                  | 34 - 45                | 26 - 35                | 46 - 55                | 26 - 35                |
| Manuals                                                         | 26 - 35                | 0 - 5                  | 26 - 35                | 0 - 5                  |
| Others                                                          | 0 - 5                  | 0 - 5                  | 0 - 5                  | 0 - 5                  |

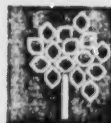
Level of interest in various information sources  
in % in United Kingdom / Aslib 1968

Table 3

| Information sources                   | % answers accepting<br>a given information<br>source |
|---------------------------------------|------------------------------------------------------|
| 1. Periodicals                        | 25,1                                                 |
| 2. Patent and invention literature    | 14,9                                                 |
| 3. Firm literature                    | 14,2                                                 |
| 4. Researches                         | 14,2                                                 |
| 5. Books                              | 8,9                                                  |
| 6. Information of similar enterprises | 4,9                                                  |
| 7. Bibliographies                     | 4,                                                   |
| 8. Branch bulletins                   | 3,8                                                  |
| 9. Standards                          | 3,6                                                  |
| 10. Documentation cards files         | 2,9                                                  |
| 11. Technical-economical factors      | 1,3                                                  |
| 12. Reports on abroad travels         | 1,2                                                  |
| 13. Expertises                        | 1,1                                                  |
| 14. Technical guides                  | 0,8                                                  |
| 15. Express-information               | 0,5                                                  |
| 16. Others                            | 1,1                                                  |

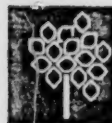
Researches on information needs performed  
in Poland, 1966/1967.

WFEO|FMOI

Table 4

| Information sources                  | Scientists                 | Engineers |
|--------------------------------------|----------------------------|-----------|
|                                      | % participation of sources |           |
| Abstracts                            | 15,3                       | -         |
| Technical and scientific periodicals | 15,2                       | 9,8       |
| Foreign periodicals                  | 11,2                       | -         |
| Patents                              | 7,4                        | -         |
| Technical calendars and guides       | 6,9                        | 12,2      |
| Bibliographical indexes              | 5,3                        | -         |
| Industrial catalogues                | -                          | 5,2       |
| Contacts with confreres              | -                          | 7,6       |
| Manuals                              | -                          | 9,8       |
| Reports on researches                | -                          | 9,2       |
| Other information sources /24 kinds/ | 40                         | 40        |

Study among engineers and scientists in Soviet Union, 1967



#### 4 - Characteristics of information used

- Multi-disciplinary,
- Technical, economic, social,
- Multiple. For a given need, it is used at the same time : data, plans, tables, etc...

#### 5 - Requirement of engineers

The requirements of engineers demand information based on reliable and actual sources, proper as regards subject matter and elaborated in, easy for its using, form and delivered rapidly, so as the decisions could be undertaken in proper time. Information can be provided in form of a primary document, in form of a secondary document, indicating the original document, and in form of a secondary document but containing information giving ready answer for user's requirements and making available undertaking decision.

As results for the above described functions and features of engineer's work, he has not practical possibility to study many primary documents. This is the reason that the most proper form of information for engineers is the factographic information, analytical-synthetical elaborations and states of arts. The first kind includes figures information and data on products features and parameters, chosen from the primary documents / adopted to the given branch, e.g. chemical formulae for chemistry/.

Analytical synthetical elaborations contain information on a given problem, elaborated of the ground of many various documents.

States of arts present information of actual state of a problem basing on the critical analysis on the ground of many documents.

On the other hand, the interest of making inquiries varies according to the practised function :

- the technician feels a little suspicious about whatever he does not understand or also he does not know how to use ;
- the practitioner is only interested in information directly bound up by concrete problems that he treats, and which are immediately utilizable ;
- the decision and prevision-maker used to seek accurate, trusted, immediately verified and directly utilizable data.

WFEO|FMOI



### Conclusion

Such classification of engineering activities and their specific information requirements presented in chapters II and III have to be discussed, classified and developed, as to

- engineers and engineering activities in the context of scientific, technical, social, economic and cultural development ;
- interrelations of engineering information and scientific, and technical information ;
- economic, social and cultural information needs of engineers.



#### IV - DETERMINING THE INFORMATION NEEDS OF ENGINEERS - METHODOLOGY

---

1) One of the most important aspects of planning or developing information systems consists of evaluating or determining the requirements of the systems' potential users.

The study of these requirements has been and is currently the object of numerous works which are as much the projects of international as of national organisations. Conferences bearing on the problems of scientific and technical information for the engineer regularly tackle this question, and at times in detail. International information committees have created within their frameworks specific work groups whose object is to study the various aspects of determining the scientific and technical information requirements of the engineer.

In fact, the problem is primarily relative to the choice of a methodology. Our present concern being to discuss the determination of the engineer's industrial information requirements, we have presented a methodological approach which may be applied, *grosso modo*, to all countries, bearing in mind at the same time that partial adaptations may be necessary.

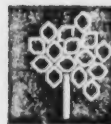
In fact, the problem posed differs little from that of a marketing study ; it is a question of defining, qualitatively and quantitatively, all correlations between, on the one hand, a product - the scientific and technical information - and on the other hand, its real or potential consumers - the engineers. This parallelism between a study of requirements and a marketing survey has led us to discuss the following questions :

- What is the engineering population - how many are they, where do they practise, what functions do they assume ?
- With what kind of information are we dealing ?
- By what means ought this information be transported to its user ?

This conception must nonetheless be conditioned by two fundamental points :

1. Such a study is generally carried out with a view to the establishing of new systems or the adaptation of existing systems so as better to meet current needs. There is thus a need for planned action. A priority based on the idea of the engineer's sector of activity ought to be taken into account.

Hence the weight of such sectors in the national economy ought to be gauged.



2. The engineer's habits and attitudes as regard existing information services - be they national or international - are also elements which reflect certain aspects of his information requirements.

## 2) Identification of sectors having priority

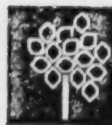
This preliminary work is necessary for two reasons :

- Firstly, as we have just pointed out, it would be unreasonable to pretend to be able to meet, simultaneously, the needs of the sum of a country's different sectors. A structuring of the interest to be accorded to various sectors is thus necessary. This planning cannot but establish certain priorities. It is obvious that, for a given country, the priority accorded to different sectors, will be a function of their weight in the national economy.
- Secondly, the combination of sectors having priority at an international or regional level permits the establishment of an order of priorities. This enables the progressive implantation of systems arising not only from national projects but from communal projects to which each nation contributes in accordance with, on the one hand, its own requirements, and on the other hand, the economic considerations within which such systems are realized.

Different methods may be employed in determining the weight of a given sector in the structure of the national economy. We quote two of these :

- i) in a planned economy, the data one may assess from the plan itself are generally illuminating ; these data may consist of :
  - . Analysis of the extent of investment realized or to be realized in a given sector ;
  - . Determination of the percentage of the sector's contribution to the gross national product.
- ii) in all cases, the other factors revealing the sector's importance in the national economy are :
  - . the number of industries and their size ;
  - . employment ;
  - . and, of course, the number of engineers exercising in the given sector

These basically objective elements will not always constitute sufficient grounds for deciding whether a given sector ought to be given priority over another. Non - quantitative considerations may also be taken into account - and may even be the determining factors. These considerations may be a purely political order, or may be dictated by the nature of the sector's demands, in which case they will stem from the motivation of the technical community in question, the level of qualitative development of the sector, the nature of the sector itself, or its strategic importance in the country.



### 3) Determining the engineering population

National census offices, engineering associations, universities and schools of engineering are equally capable sources for providing figures, actual and projected, which permit the evaluation of engineering populations according to specialisation or according to economic sector.

This apparently simple action necessitates the establishing of national dossiers verifying the number of engineers, a task which could be rapidly executed in countries where the number of engineers is relatively small, numbering in the thousands, or in those countries where the exercise of a professional activity necessitates enrolment with an engineering order. In countries answering to neither of these criteria, the task could well prove to be a more difficult one, but remains nonetheless imperative if a study of engineering information requirements is to be made. After all, doesn't a marketing survey base itself first on estimates of its clientele, real or potential.

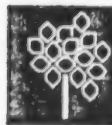
### 4) Functions of the engineer

We have demonstrated that a correlation exists between, on the one hand, the engineer's information needs and, on the other hand, the responsibilities he assumes in his work. In this case also, a quantitative notion (that of the number of engineers) ought to be linked with a restructuring of the functions that may be ascribed to an engineer in his business.

Certain inquiries have revealed that a single engineer is frequently called on to exercise a variety of functions, which may at times present a contradictory appearance. This situation arises either from the country's industrial structure or from the inherent inadequacy of the engineering framework, or from the country's scientific and technological development. This comment reveals a certain difficulty that arises in attempting to determine the type of information that should be made available to the engineer.

Bearing in mind this problem, we must nevertheless study from a qualitative point of view the engineering population. Initially, this will help us to establish priorities as regards the type of information to be offered. A classification based on data given in chapter II of the present study might be adopted.

A relevant point to be raised here is that the allocation of engineers in accordance with the functions they assume, cannot within reason, be exhaustively carried out in several countries, thus justifying the use of sampling methods. In such cases, this classification would be effected across a sufficiently representative cross section of the country's total engineering population.



### 5) Types of information sought

It is possible for us to list the types of information likely to interest the engineer, in function of those sources of information that are currently available.

Without being exhaustive, the following list may serve as a basis for determining requirements :

- Documentation organizations which :
  - . Group, classify and diffuse the documents themselves,
  - . Or those which group and diffuse analyses of documents,
  - . Or data banks which group information as such.
- Organisations which group specialists, such as trade union committees or builders' organizations.
- Commercial organisms specialized in the collection and dissemination of information bearing on a specific sector.

This preliminary assessment of possible information sources and aids corresponds to an objective evaluation of the types of information sought after, or at least, likely to be needed. It is furthermore essential to take into account, whilst studying engineering needs, other factors of which certain are subjective. Amongst such considerations, there is the fact that engineers have acquired habits and traditions according to which they tend towards certain kinds or sources of information. Consequently, through ignorance or through force of habit, certain kinds of information are not sufficiently sought after by the engineering community.

A second factor to be taken into account is the fact that the currently practising engineer has not generally received any training as regards the exploitation of information systems. This state of affairs will evolve, and with it the number of engineers motivated by such questions, who will thus have different attitudes.

These are certain of the factors which will necessarily influence our "marketing survey", if it is to be sufficiently prospective.

### 6) Usual methods

Apart from the methodological approach which has just been given, it is necessary to recognize the fact that commonly employed methods have been based on research stemming from the diffusion of questionnaires, distributed within institutions or at events characterized by a high concentration of engineers. Despite the inconvenience arising from such methods, due essentially



to their partially subjective nature (subjectivity in the framing of the questionnaire, as its author(s) is(are) naturally inclined to orientate the questions posed ; subjectivity also as regards the person filling out the questionnaire, who often replies according to a recent and actual experience), the scrutiny of such investigations does give a close approximation of requirements.

These enquiries are in most cases carried out by international organizations, engineering associations, scientific groups or lastly by public or private centres of scientific information.

We have provided in chapter III the results of some such enquiries. As an example, we present here the WFEO/CEI investigation on the data needs of the engineer.

7) Example of studies on engineers information used :  
WFEO/CEI survey on the utilisation and sources of engineering data

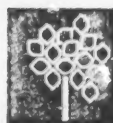
WFEO/CEI created in 1973 a working group on "Engineering Data". The objects of these groups were "to identify the availability of sources of engineering data throughout the world and as long-term objective to consider the evaluation of data and quality of information provided for engineers, possibly leading to the preparation of guidelines for the evaluation and presentation of engineering data. The groups activity was initiated with the circulation of a questionnaire, to all National Members of WFEO, seeking details on engineering data sources available in their countries.

- The questionnaire contained the two principal questions :
- the types of data used by engineers (differentiation of data by content) and
  - the sources of data (data carriers, data bases).

In the first principal question (types of data), the data relevant to the engineer were divided into eight groups :

1. Property data
2. Design data (in a narrow sense)
3. Product data, product parameter
4. Standards, regulations, laws
5. Data on production and manufacturing procedures
6. Companies and their marketing products
7. Market information
8. Data in the field of socio-economy and ecology.

## WFEO|FMOI



In the second question, which is very important for the subsequent work, groups of sources were enumerated as follows :

1. Handbooks, manuals, table volumes, reference books, comprehensive data books
2. Product information, press release
3. Technical standards and codes of practice
4. Laws (juridical)
5. Company's handbooks of design data
6. Collection of drawings
7. College notes, study notes, lecture essays
8. Exchange of personal experiences
9. Technical books, special interest books
10. Patents
11. Technical journals, trade magazines
12. Reports
13. Secondary literature
14. Data information services
15. Statistics
16. Salesmen reports
17. Other data sources (e.g. Data centres, laboratories)

and indications were requested on the frequency of use times per month and possibly per year and no. In addition to the question on the frequency of use, the importance (usefulness factor) of the various data sources was asked for. The person completing the questionnaire was asked to indicate the four data sources which appeared to be the greatest importance to him in his work, by evaluating them in the sequence 1, 2, 3 and 4 where "1" indicates the greatest degree of usefulness. By means of this additional question, an attempt was made to establish whether there is any correlation between frequency of use and usefulness of the sources.

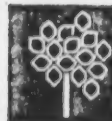
The second part of question 2 requests a listing of the titles (books, etc.) of the normally used sources.

The supplementary question 3 "Do you have access to existing documents and data ?" would show up any difficulties.

The two final questions as to the branch of the economy in which the surveyed person is employed and to its size and the field of activity of the surveyed person, were intended to allow for the possibility of establishing a correlation between the use of data and the field of activity of the engineer.

387 questionnaires, plus accompanying letters in the english language and 28 in german, were sent to the national WFEO members in 71 countries (except Germany). The members were asked to distribute the questionnaires to engineers whose working situations were characteristic of the country.

# WFEO|FMIOI



Organizers received altogether 162 usable questionnaires from 20 countries (= 28 %) out of the 71 countries contacted (except Germany).

There were following results of the evaluation of answers to question 1 : the answers to the qualitative question 1 as to the types of data and documents used by the engineer in his work do not provide a very differentiated breakdown of the types of data used, especially for the WFEO base. In the narrow band of only 13 %, there are five types of data with product information (71 %) at the top, followed by standards (682), design data (61 %), companies and their marketing products (60 %) and property data (58 %). Data in the field of socio-economy and ecology still amount to 20 %, so that none of the 8 types of data listed can be ignored in subsequent studies. The German replies are considerably better structured, undoubtedly as a result of a certain degree of pre-selection from the totality of engineers (predominantly design and development engineers).

To question 2 : in question 2, 16 sources of data used were offered and quantitative replies were requested :

- A - PU (frequency of usage) and supplementary
- B - a rating (R) of the sources.

The most important result of evaluating question 2 showed that information values of data can be divided into 3 ranges : the enumeration is according to the decreasing rating,

## 1. High information value

- Technical journals
- Handbooks, manuals, reference books, comprehensive data books
- Technical books
- Reports
- Exchange of personal experiences
- Technical standards and codes of practice
- Product information

## 2. Medium information value

- Secondary literature
- Company's handbooks of design data
- College notes, study notes, lecture essays
- Data information services
- Collection of drawings

## 3. Low information value

- Laws
- Patents
- Statistics
- Other data sources
- Salesmen reports.



The representativeness of the results of this study could be being questioned because

- 1) important countries could not be considered since they did not reply, and
- 2) the numerical basis as to field of activity and distribution among different sizes of organizations appear to be probably not sufficiently close to the actual distribution. Therefore, the results obtained can only be considered as a trend of the studied group.

The characteristic feature of studies carried out by WFEO/CEI is this that there were not studied the needs, but there collected data, which, in fact, were used by the respondents.

### Conclusion

This overview of the methodological problems of user studies concerning engineering information is not sufficient to settle a methodology. Some problems are not quite resolved :

- interrelation of information needs, information demand and information collecting habits of various types of engineers ;
- effects of the socio-economic structure of the society : planned or free market structure ;
- advantages and problems of different survey methodologies ;
- the market of engineering information services, information demand and offer.



#### V - STI EVOLUTION - ITS ROLE IN ENGINEER'S WORK

Having set forth the characterization of the engineering profession as the background for discussing the role of information in the engineer's work, it is necessary to pause and review the changing nature of information itself: this concept has been analysed by Ernst and Giuliano (1) who have identified three historical stages of scientific and technical information (STI).

- Era I is identified as the "discipline-oriented" stage of STI. During this era, the traditional scientific approach was predominant. This approach can be characterized by the systematic growth of knowledge with close ties to basic research. This era is said to have lasted up to about World War II.
- Era II is identified as the "mission oriented" stage of STI. The "big science" applications of military and space programs and their secondary impact upon the commercial sector, this era began with World War II and continues today.
- Era III is identified as the "problem oriented" STI stage. The need for engineering application to recognize the socio-economic-political impacts of science and technology has become a new and necessary aspect of STI. This era is believed to have begun in the 1940's, and of course is continuing today.

The impact of these successive changes upon information and information needs is easy to see. In Era I, engineers could rely basically upon libraries for information. Scientific principles were translated into text books. Data accumulated at a slow pace and were presented in journal articles and gradually found their rightful place in applications handbooks and standards.

Era II produced both more complex needs and more complex output of information, resulting in the "information explosion". With more practitioners in the field, more information was produced. With mission orientation, the information became increasingly interdisciplinary so that potential users of the information had to rely more and more upon unfamiliar data sources. Very naturally, the operations research and computer-assisted methodologies of engineering itself were emulated in the capture and dissemination of STI. Computer-based information systems were developed.

(1) Martin L. Ernst and Vincent E. Giuliano, "Information transfer Eras and implications for scientific and technical information", Arthur D. Little, March 1977.

# WFEO|FMOI



Era III developed the need for transdisciplinary information. Engineers became responsible, not only for developing products and services derived from science and technology, but for measuring, and even aiding, their impact upon society as a whole. Now, the engineer must be concerned with secondary and tertiary impacts upon such matters as energy production and use, the environment, national economic goals, and a host of considerations subsumed under the rubric of the "quality of life". At the same time, policy makers and behavioural scientists have shown increasing need for access and evaluation of engineering information for their evaluations of the same impacts.

To summarize the social role of the engineer : in Era I, the engineer was responsible mainly to Science, in Era II, to the profession of engineering, in Era III, to society and its consumers of engineering output.

## STI Technology Evolution

The field of information science has by no means been immune to the changing information needs of engineers and others. In the discipline-oriented information systems of Era I, information science was dominated by librarians. Information was recorded on hard copy, captured, abstracted and indexed.

The mission requirements of Era II soon overwhelmed the librarians, who had to turn to the computer-assisted automation of their processes. Hard copy then gave way to computer-based data banks and associated insertion and retrieval processes.

But even the computer-assisted routines of library science and computer science have proven inadequate to meet the complex needs of problem-oriented Era III STI. Increasingly, a new profession, "Information Science", is emerging to meet these needs. Initially, the focus of this new movement was upon "system" solutions to the problems ; that is, recognizing that information is a system which can be understood and manipulated. That, however, is easier said than done. Information scientists now recognize that they must first understand the nature of information and data before implementing a systems approach.

Kunz and Rittel (2) have identified three fundamental problems that now beset information science :

1. Overcoming preoccupations with scientific and technical information. Scientific disciplines and technological professions jealously guard their rights to develop their own methodologies, communications,

- (2) Werner Kunz and Horst W.J. Rittel, "Information Science : On the Structure of Its Problems", Information Storage and Retrieval, Vol. 8, pp. 95 - 98, Pergamon Press.

## WFEO|FMOI

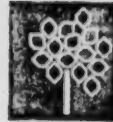


determination of peers, and criteria of judgment. They look with suspicion upon any group that threatens those rights. To some extent information science is perceived by some as a threat, because it is believed to claim there are common information processes that transcend traditional boundaries. These boundary disputes have hampered the efforts of information science.

2. "Stripping the eggshells" remaining from the ancestor disciplines. As any attendee of an ASIS conference probably can attest, significant numbers of library science and computer science practitioners still attempt to perpetuate the anachronisms of their fields. They represent large vested interests in terms of considerable economic investment and intellectual dedication to their respective disciplines. New technology and new concepts frequently are viewed by them as threats to these investments, or at best, as means that can be used to perpetuate the investments. Seldom are they viewed as new frontiers presenting new challenges and solutions.
3. The inability to date to find a systems approach. A variety of factors have hampered this attempt : individual disciplines have tried to develop their own systems that inevitably come in conflict with other systems ; systems are regarded by some as simply automation of existing processes ; unrealistic models are forced upon complex informational exchange processes. To systematize information, one must first understand the nature of information, and without this knowledge, the system most probably will fail.

Hardware and software have had great influence on the evolution of information science. The discipline orientation of Era I was characterized by the development of indexing procedures for capturing and classifying scientific and technological information, and by abstracting to summarize the substantive content of published information to provide preliminary, abbreviated preview of contents for users. In this library era automation was pretty much limited to use of typewriters, replication of results through printing, and primitive searching routines by use Royal MacBee cards. Increasing the speed of information dissemination could be said to be limited to the use of pneumatic devices or even roller skates within the confines of the library. Conceptually, emphasis was placed upon refining Dewey decimal-type systems, and standardization of citation and indexing formats. As computers became more wide-spread, printing processes were automated from initial capture of information to its dissemination.

# WFEO|FMOI



The information explosion of the mission-oriented Era II coincided with the development of computer-assisted processes of information capture and dissemination. Library scientists found the computer helpful in a variety of tasks ranging from just simply keeping abreast of the titles of journals and books available to them to the automated insertion and retrieval of indices and abstracts. Two new concepts emerged : data flagging was used to denote abstracted information which contained numerical data of potential interest to researchers to narrow the search ; high-speed searching routines were employed to develop files of needed information. Emphasis was placed upon developing enhanced searching routines and the data banks proliferated. The Dewey decimal-type systems proved inadequate to the tasks at hand, and "machine-readable" routines and algorithms were developed to use computers to fuller advantage. Unfortunately, these developments in themselves led to new problems. Very simply, gate keepers and users of information alike soon drowned in a sea of data and information. Conflicting systems each demanded that "idiosyncratic" searching routines and nomenclature be mastered. The problem of too little information was supplanted by the overwhelming problem of too much information. As the variety and quantity of information proliferated, users and intermediaries alike were unable to judge its quality. Obtaining hard copy of needed information became frequently difficult if not impossible ; giving a tantalizing glimpse in abstract of needed information but delivering it probably long after it was needed. And, most frustrating of all, the intended users of the sophisticated information systems frequently turned their backs upon them to the chagrin of those who had prophesied an information revolution.

The problem-oriented approach of Era III has begun to deal with these difficulties. Apart from fundamental inquiries by information scientists into the basic nature of information and data, movements are afoot to develop :

1. Proper data evaluation. Information Analysis Centers (IAC's) are being established to evaluate the world's literature on a given scientific or technological subject, evaluate the information they contain with respect to accuracy and precision in the context of the state of the art of the discipline, and capture both the data and the evaluation in data bank form.
  - 1.1 - Data syntheses can be generated from the data banks to display information in graphs or tables, together with estimates of their probable accuracy.
  - 1.2 - Statistical and mathematical models can be employed to provide estimates of currently missing data by plotting those points from what is known.
  - 1.3 - The IAC data bank allows users to specify the parameters of a problem and obtain the answers which best fit, without first having to specify preliminary "guesstimates" of the probable answer. Once such answers are obtained, original document sources can be obtained for further study.

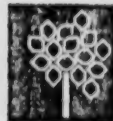


- 1.4 - Greater assurance is obtained that data have been evaluated objectively, and that a thorough search has been made of all known potential sources of data.
2. Intermediary enhancement. Gradually, "information brokers" are emerging who synthesize the traditional library and computer science skills with information science insights, and substantive and methodological knowledge of user needs.
3. Participant-defined systems. Users, as individuals or groups, sometimes assisted by skilled intermediaries, are being given the means of formulating their own searching procedures, languages and vocabularies according to their idiosyncratic needs, instead of having to adapt to off-the-shelf methods and materials that may not suite their purposes.
4. Feedback utilization. Records of user interactions are being developed to provide information on areas of interest and missing information. Methods are being created through which users can report their own empirical experience in applying information.
5. Electronic information exchange. The marriage of contemporary information and communications technologies is establishing the basis for direct and evaluative information exchange among the users, evaluators and authors of information. Utilizing advanced technology, off-line hard copy storage and production frequently can be by-passed.

### Conclusion

In the context of the new orientation of the UNISIST programme of UNESCO, the recommendations of the ACAST Colloquium, the new programme structure of the International Federation for Documentation, the development of the Industrial Technological Information Bank and other information services of UNIDO, it should be examined the expected results from the point of view of engineering information users :

- Join new trends in the development of these programmes and services,
- The expected results in the short run and long run,
- The role of engineering societies in initiating and supporting the expected development of information services.



## VI - THE EDUCATION AND TRAINING OF ENGINEERS IN THE USE OF INFORMATION BANKS

### INTRODUCTION

The education and training of users of scientific and technical information has been a topic of considerable interest in the last few years. UNESCO published a UNISIST guide for teachers in this area as recently as 1977, the National Science Foundation (USA) has sponsored demonstration projects in training engineers in the use of technical information, and many organizations, universities, publishers, and information retrieval services have concerned themselves with this issue recently.

This interest has resulted in part from a renewed realization of the importance of technical information (particularly in developing countries), the availability of support funds from various organizations such as UNIDO and the National Science Foundation, and most importantly, from the availability of easily-accessed computerized sources, referred to as information banks.

There is some confusion in the information and technical communities about the term "information banks", because there are also references to databases and data banks. The former are frequently divided into bibliographic and non-bibliographic databases, although they may also be referred to as "factographic" databases. The term data banks most often refers to those computerized files of information which contain actual data, as contrasted to the bibliographic type which contain surrogates or "pointers" to other sources where that data may be found.

The way in which this information in the information banks is acquired is also subject to some confusion because the most emphasis in the last few years has been in the area of "online" information retrieval systems. It must be remembered that the bulk of computerized information retrieval in the world is still accomplished by "batch" (that is, in a non-conversational mode with the computer) retrieval services. However, it is the advent and popularity of online information retrieval services which have accelerated the education and training of the engineering community, that they may be relatively self-sufficient in satisfying their information needs.

One might well wonder why there should be any effort to train engineers in the use of information banks when there is a professionally trained library



and information community to accomplish these tasks. Perhaps, this question can best be answered from the UNISIST guide for teachers mentioned above. The authors specify that the potential user benefits from training the scientist or technologist are :

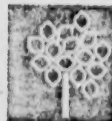
1. Higher standards and higher productivity result from the development of the ability to study a chosen topic independently, gain awareness of existing knowledge in a specified area, acquire detailed data and comparable factual statements and be aware of new developments of potential value. There should also be less duplication of effort or repetition of failures.
2. More efficient use is made of available literature because users can search directly when either necessary or advantageous. In addition, awareness of the possibilities and problems of information retrieval makes for better indirect use - through external information services.
3. The effective use of information indirectly advances technological development in the national interest.

The guide goes on to point out that "information retrieval is really a part of the communication process, and this can be seen most clearly in technology and its relationships with the physical and social sciences. Anyone who doubts this should read some reports of enquiries into the causes of disasters". "In many cases the causes include a combination of human fault, information retrieval fault, and communication fault". The Assistant Director General for Science in UNESCO has stated that "the importance of technology transfer lies in its ability to stimulate and strengthen the innovation process. The role of information on current R&D in this area of particular interest to the developing countries cannot be overemphasized".

The objectives to be realized in training engineers in the effective use of information banks are :

1. "To increase productivity and reduce the problems of industrial and commercial enterprises by making more effective use of information resources in the company or the region.
2. Engineering practitioners should be aware of the recent developments and innovations which directly affect their work.
3. They ... should be able to carry out a feasibility study, or that part of a feasibility study which involves a survey of existing published knowledge on the topic.
4. Engineering practitioners should be able to acquire data and factual items of information which may be needed in the laboratory or workshop, or in any other aspect of their vocation. In addition, they should be able to apply national limits of applicability and confidence to the values.

# WFEO|FMIOI



5. To be able to locate organizations which are prepared to give information relative to the field of work.
6. To be able to appreciate... the role and potential value of scientific and technical information" ; management and control factors related to information needs ; "the relative merits of using information services and searching for information oneself ; and the obstacles and limiting factors, particularly of terminology.
7. To appreciate the relevant special categories of information and literature applicable to engineering ".

The similarities of the training objectives between developed and developing countries lie in the varying attitudes exhibited by the practitioners. Some will see the use of information banks as the means to a specific practical solution to a problem - that is, a highly pragmatic attitude. Others will view information use as leading toward the development and refinement of ideas. The primary difference between the developed and developing countries is that there is perhaps considerably more emphasis on practical objectives which coincide with areas for development, many of which which may be local in nature and circumstance.

## THE EDUCATION AND TRAINING PROCESS

The traditional manner in which continuing education (that is, postgraduate education) of engineers has been accomplished was through "on-the-job" training, with an occasional special seminar or symposium to be attended in another location, usually associated with a professional meeting. In addition, the motivating force behind such continuing education was, generally, a somewhat urgent need to solve a particular problem. Less often, the motivation was for an improvement in job status, or perhaps, a firm suggestion from management.

In recent years, there has been a considerable re-evaluation of both the information needs of engineers and the best environment in which to learn techniques to satisfy these needs. Some of identified information needs of engineers include :

- 1) an awareness and current understanding of the subject area before approaching a new job, project, or task ;
- 2) awareness of new processes, materials, products, ideas, techniques, which may influence current work ;
- 3) data and product information necessary to execute an assigned job ;
- 4) frequently, the knowledge that no research or development has been approached for a given problem ; and
- 5) sources of available funding to proceed on a particular project.

# WFEO|FMOI



Some of the specialized information needs of engineers include data and factual information, product and materials information, information on patents and standards, and "news". It is interesting to note that estimates have been made indicating that of all usage of information banks which contain data (rather than references to the literature), 79 % of that use is by the person who needs the data (i.e., the end-user). These figures strongly suggest that special emphasis should be placed on enabling engineers to use these specialized information banks of DATA by themselves, with little or no mediation by an information professional.

Suggestions for the best learning environment for the practicing engineer include that the content be directed toward that which is pragmatic and practically applicable in the work setting ; that lecture formats be limited, that units be well-organized ; that full advantage be taken of the accumulated knowledge available within the assembled group ; and that, in so far as possible there be supervised practical sessions.

## RECENT DEVELOPMENTS IN EDUCATION AND TRAINING FOR COMPUTERIZED INFORMATION BANKS

Recent activities in the developed countries in the areas of education and training have been many and varied. These activities have been conducted by many different agencies, including database producers, information retrieval services (both private and government), consulting concerns, universities, governments, and professional organizations.

Database producers are devoting increased efforts to conduct seminars and training workshops, as well as new efforts to provide supporting printed documentation to be used as training aids for the effective manipulation of their databases. Engineering Index, Inc., Chemical Abstracts Service, INSPEC and the American Petroleum Institute Central Abstracting and Indexing Service, among others, have made efforts to provide guidance in the use of their information banks.

Information retrieval services, such as the System Development Corporation's ORBIT, Lockheed Information System's DIALOG, ERS, the European Space Agency's IRS/RECON, and services provided by the Canadian government's CAN/OLE service and the Federal Republic of Germany's Fachinformationzentrum service have been providing training support directly to the technical community through seminars in their own countries and abroad, including Western Europe, Mexico and Japan.

## WFEO|FMIOI



Private consulting concerns, such as Cuadra Associates and others, have begun seminars oriented to all members of the information-needy community, particularly in the area of data banks (those information banks dealing with facts instead of literature references). Private consulting concerns, such as Cuadra Associates and others, are offering seminars and services in the area of data banks (those information banks dealing with factual data).

University programs aimed at the engineer or technologist have been reported from Loughborough University of Technology (UK), the Royal Institute of Technology (Sweden), the University of Kansas (USA), and Finland.

Programs of national governments include those already mentioned from Canada and West Germany, as well as programs supported by Australia, France and the U.K.

The specific kinds of training which are currently in use emphasize two major aspects of the effective use of information banks. The first aspect is a thorough familiarization with the database itself. This includes such information as the general subject and time scope of the database. In addition, it is necessary to know which are the materials covered (such as journals, conferences, patents, numerical data, production forecasts, etc...). The various ways in which the materials are indexed and organized are also of considerable importance. These aspects provide a sound foundation for the use of the information bank.

The second aspect is a thorough familiarization with the mechanics of using the specific information retrieval services. Unfortunately, there is little standardization amongst the various services. This causes a great deal of frustration and ineffective learning effort on the part of the technical user and has, in fact, been part of the justification for the use of an information intermediary. However, as it is necessary for the engineer to learn the language of mathematics, physics, and chemistry, it is advisable that engineers will also learn the various "languages" required in order to make effective use of the information banks which are available to them. Some of these information banks have computational facilities built into the system, thus enabling the engineer to maximize the effective use of his time.

The true infrastructure of education and training in the use of computerized information banks lies in a necessary understanding of the intersection of the two above-mentioned aspects, namely, the manner in which a given database is utilized by a particular information retrieval service. This fundamental understanding of a retrieval system's computer programs, and to what extent the engineer-user must specify the actions to be undertaken in the search for a piece of information, is the subject of considerable interest. This man-machine interface is, perhaps, the single most important ingredient in the



successful use of information banks by engineers. At the same time, it is one of the most neglected aspects in the training and education programs of today.

#### PROBLEMS ENCOUNTERED IN EDUCATION AND TRAINING PROGRAMS

The increased activity in the area of education and training programs for computerized information banks in the developed countries has led to some associated problems. Some of the most obvious ones are :

1. The availability and proliferation of information banks, leading to frustration for the engineer in the selection and evaluation of the best ones to use.
2. The increased need for a better understanding of WHY to use information as well as HOW to use information.
3. The associated costs of providing extensive training programs.

Solutions to these problems may be found in improved and enriched information-seeking training for engineering students during university level education as well as in effective continuing education programs for the practicing engineer.

#### ACTIVITIES AND PROBLEMS IN TRAINING PROGRAMS IN THE DEVELOPING COUNTRIES

Activities in the developing countries have most often been approached in a somewhat different manner. Although some of the same kinds of organizations are involved, the type of activity, the sponsorship, and the associated problems are considerably different. Primarily, many of the education and training activities in information bank use have been the result of interaction between some international agency and the national federal government.

Although some information bank producers (most notably, the American Petroleum Institute) have been fairly active in training technologists in developing countries, it has not been the general or common occurrence. Likewise, although the information retrieval services have been extremely active in training activities in developed countries, their activities have been limited in the developing countries, primarily due to problems associated with telecommunications restrictions. Universities, with international agency sponsorship, have made some progress, specifically in South Korea and Indonesia.

Returning to the international and national government agency cooperative programs, although there have been many programs which have established or attempted to establish information centers or services in Southeast Asia, Africa and Latin America, it seems that relatively few of them have placed very much emphasis on the training of the engineer as the ultimate user of an information bank.

# WFEO|FMOI



Notable exceptions to the above are to be found in Latin America. The Peruvian government has established a technical information center known as ITINTEC in Lima, which maintains an aggressive program of training Peruvian technologists in the use of information banks. Although this training is focused primarily on manual retrieval methods, some computerized retrieval services are available.

Additionally, INFOTEC, established by the Mexican government's CONACYT, has established a strong program of technical assistance and training courses which are available not only to organizations in Mexico, but to their colleagues in the rest of Latin America as well.

The problems associated with training engineers to use information banks in the developing countries are significantly greater than are the problems in the developed countries. Some of them are :

1. The lack (rather than the plethora) of information banks.
2. The regulatory problems concerning the use of telecommunications networks.
3. The increased need to establish a fundamental understanding of the importance and value of information.
4. The urgency of need to establish training programs to enhance the technological developments necessary.
5. The extraordinary costs involved to develop and establish education and training programs for personnel in the technological environment.

## SUMMARY AND CONCLUSIONS

This chapter has attempted to report and describe the characteristics associated with the education and training of engineers in the use of information banks. It has reviewed some of the major developments and activities in both developed and developing countries. Problems have been identified, and some partial solutions proposed. There are no easy answers to the complex problems associated with the cultural, attitudinal, and educational attributes of the engineer/technologist in any country. However, it seems clear that significant progress in such training goals cannot be reached until there is an improved awareness on the part of university engineering faculty of the critical importance of information banks, and their effective utilization. Integration of techniques for accessing information banks can easily be included in the engineering curriculum, and the basis for a productive technical lifetime can be significantly influenced at this university level.

It also seems clear that continued support from national federal governments, professional organizations, developmental agencies, and international organizations is also critical, particularly for the developing countries.



## VII - SPECIFIC PROBLEMS OF DEVELOPING COUNTRIES

Our study of the engineer's scientific and technical information needs would be incomplete if we do not mention certain of the specific problems faced by developing countries.

The reviewal of these particular problems gives our subject an aspect that must be taken into consideration wherever solutions are sought to the problems posed in supplying the engineer with adequate information, in adequate form and at the right moment.

- A - Engineers in developing countries reflect, in their information needs, certain characteristics which distinguish them from their colleagues in countries that are technologically more highly evolved. These characteristics incorporate : the functions to be fulfilled by the engineer, the types of information he is seeking and the nature of his own training.
- B - Compared with developed countries, those that are developing present certain endemic factors which create "natural barriers" to the diffusion of information and to its availability to the engineer. These barriers are as much the consequence of the community's overall technological level as of the human potential factor regarding the communication means of the infrastructure.

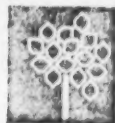
### 1) The engineer's functions

The definition of the engineer and the description of his specialisations and functions, as given in chapter II is of course a universal one, and thus applicable to the engineer from a developing country.

- A - Nevertheless, the distribution of the engineering community as regards the functions to be assumed is of a distinct kind in developing countries.

One can in fact estimate that a high percentage of the engineers in these countries (approximately 95 %) will be divided into three main groups :

- . functions of directing and managing either industrial or general economic areas,
- . functions of production and exploitation of factories, workshops, agricultural enterprises, etc..., in which case the tasks involved include organization of production lines, of methods of control, of the realization of works and of the maintenance of equipment.



And according to a recent and growing tendency :  
 . functions of studying and realizing industrial units.

The concentration of engineers across these three groups of functions is such that the tendency towards engineering research - basic or applied - or towards university teaching remains a marginal one in developing countries.

- B - In these same countries, a single engineer is often called upon to exercise a variety of functions, and thus at times to present a contradictory image. For example, it frequently happens that an engineer directing the technical service of a ministerial department or a national enterprise be at the same time responsible for defining the development policy of a country's industrial or economic sector, that he undertakes the day to day running of this same area, and that he be responsible, furthermore for the teaching of some branch of a scientific discipline in an institution forming professionals.

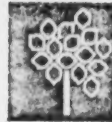
Such instances are generally the result of the developing country's inherent lack of engineers. Whatever the case, realities of this kind condition the nature of information having priority for the engineer in a developing country.

## 2) Types of information

Two points ought to be made :

- A - The kind of information needed by the engineer is, as we have already demonstrated, in direct relationship with the functions to be assumed. The engineer from these countries will tend to look for technical and industrial information to meet the needs of his more important functions ; purely scientific information not being an urgent necessity for him.
- B - Developing countries have, over these past few years, experienced a veritable industrial "boom" ; however, the majority of these countries have reached, and will remain for a long time yet at a phase of consolidating, if not creating, their economic and industrial structures. Whether this be so as to ensure employment for their citizens, so as to economize on foreign expenditure, or so as to bring added value in commercializing their raw materials, these countries are becoming industrialized.

In order to carry out his role, essential to his country's development, the engineer is in need of industrial and technical information concerning procedures, patents, norms, materials, etc... ; information which is of an economic, social, judicial and even political nature.



However, such information cannot generally in fact be imported, but must be generated by the country in question, thus necessitating an organization which renders it sufficiently accessible and diffusable. It is at this level that we meet up with the fundamental aspect of satisfying information needs.

### 3) Training

Training in developing countries takes on a dual aspect : the first concerns already practising engineers, or those on the point of so doing, and the second concerns those who shall become practising engineers in due course. In its first aspect, the necessity that engineers be initiated into the utilization of information systems often arises in the course of conferences, seminars and reports. Although not a specific one to developing countries, this question assumes a particular pertinence in these countries.

In its secondary aspect, there is a need as much for the establishment of specifically oriented teaching programs in universities and in engineering schools as there is for the encouragement of the future engineer to use information means and sources, to the extent that the student's work methods reflect, in this respect, an apparent "automatism" or "natural reflex". Of course, this implies the existence of a minimal infrastructure and of its environment.

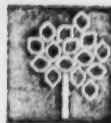
### 4) The infrastructure

It is obvious that the development of information services and systems in a given country requires the preexistence of that country's own infrastructure. It is not our task here to define such an infrastructure, however, we draw your attention to three of its aspects :

- . Human potential factor,
- . An administrative environment,
- . Adequate communication means.

A - The professional potential of developing countries as regards specialists in the information sciences, documentalists, librarians and other related specializations is naturally very limited in such countries. Furthermore, existing professional potential in these domains has often received, overseas, a kind of training that is ill adapted to the countries own realities.

## WFEO|FMOI



- B - The general administrative environment has a direct influence on the organization of information flow, and on the management of information sources and systems. Whether it be a matter of "imported" information, or of that created in the country itself, a minimum "tradition" of organization reigns in the country's administrative circuits.

This "tradition" is acquired over a period of time relative to the situation of each country.

- C - Scientific and technical information services are increasingly based on computer systems functioning in real time, the which, in developing countries, are dependent on telecommunications networks. In these countries, the telecommunications authorities, anxious to install telephone, telegraphic or telex systems to meet the pressing needs of economic and social development policies, generally accord a lesser priority to the availability of these data-transmitting networks ; the which factor necessitates a particular quality and particular technical specifications.

There is no doubt that the absence of these networks constitutes, at short or at middle term, an obstacle to the progression of scientific and technical information services in developing countries. The specific problems of developing countries have been examined at numerous international conferences organized under the aegis of specialized United Nations organizations : UNESCO - UNISIST and UNIDO.

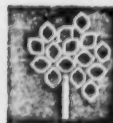
WFEO has, for its part, patronized two important conferences : "Conference on Engineering Information in developing countries" (Cairo, April 1974) and, in collaboration with UNISIST, "The International Conference on National and Regional Planning of Scientific and Technological Information Systems and Services for Development in the Arab Countries" (Tunis, April 1976).

The chief recommendations stemming from these two conferences bore on the following themes :

- . The necessity for a national policy as regards scientific and technical information,
- . The necessity for a precise evaluation of the needs of the engineer,
- . The necessity for a policy of regional cooperation,
- . Human potential and training,
- . Normalisation,
- . The communications' infrastructure.

At this point, we ought to evaluate progress made in the light of the experience and personal accounts of engineers from these countries.

# WFEO|FMOI



We will pay particular attention to :

- the existence, or lack, of national centres of valuable information,
- the existence, or lack, of industrial information networks, and of scientific and technical information,
- the possibility of there being local information services belonging to research institutes and to industrial and commercial organisms, as well as to government services,
- the possibilities and conditions of access to foreign information services and to their data banks and centres,
- the availability, in these countries, of unconventional and non-traditional sources of information,
- translation facilities and possibilities.

In this summary, the following points deserve particular attention :

- the adequacy of exterior sources of technical information in the event of technology transfer, and for socio-economic development,
- the necessity and the possibility that the engineer be supplied with information prepared in advance, which may be put to direct use,
- the planning and role of transfer of information through technology transfer.



### VIII - CONCLUSION

In this report, we have tried to discern and illustrate the main directions to be taken towards solving the problem of determining the engineer's information needs.

These principal directions may be summed up in the following terms :

- 1) The information to be taken into consideration by the engineer concerns all aspects of man's knowledge and of his environment. It can be of a scientific - technical - economic - social - judicial - political - etc., nature.
- 2) The information to be used may be defined in terms of the object envisaged :
  - . For a given engineer, in terms of the work for which he seeks information, and in terms of his own attitude towards information.
  - . For an economic sector, in terms of the sector's activity and development, in the environment concerned.
- 3) Despite the variety, the diversity, and the multitude of tasks taken on by the engineer, a typology of these tasks is possible, and would permit the correlation of one or several types of information to the different categories of tasks involved.
- 4) Consequently, the information that is useful to the engineer in carrying out a given task is always characterized by four related parameters :
  - the engineer's receptiveness,
  - the object of the work for which information is sought,
  - the working environment of the engineer : country, region, etc...
  - the field of interest.

A final question needs to be asked :

Stemming from these main directions which permit us, in a given situation, to discern with some precision the information needs of the engineer, to what extent are existing systems capable, or will they be capable in the future, of meeting these needs ?

- at the present time, the engineer's opinion leans towards scepticism,
- for the future, an affirmative reply carries with it the stakes of to-morrow.

WFEO|FMOI



### REFERENCES

In addition to quoted references in these reports, we can also mention :

- A.J. Evans, R.G. Rhodes and S. Keenan, Education and training of users of scientific and technical information. UNISIST guide for teachers. Paris, UNESCO, 1977.
- Harrison, J. Opening Remarks. UNESCO Secretariat, ed. Proceedings of the UNISIST International Symposium on Information Systems and Services in Ongoing Research in Science ; 1975 October 27-29, Paris, France. Budapest, Hungary : Hungarian Central Technical Library and Documentation Center ; 1976. 19-22.
- Tomberg, Alex. Data banks : A-survey. Proceedings 1st International On-line Information Meeting, London, 13-15 December 1977, pp. 159-168.
- Besoins en Information des Ingénieurs en Europe de l'Ouest (Résultats d'enquêtes) - Conférence de Tunis, April 1976.
- Information Systems in Engineering - Walter Grattidge and John E. Creps, Jr.
- Statistical, Economic and Marketing Data Information for Engineers, S. AL. Shaidly - Conférence de Sofia, June 1977.
- WFEO-CEI, Conference report : Conference on engineering information in developing countries, April 1974, Cairo.
- Arab committee on Engineering Information and Publication of Federation of Arab Engineers : FAE/ACEIP Conference report : Technical Conference on Engineering and Scientific Information in Arab countries, June 1975, Tunis.
- WFEO/CEI - FAE - UNESCO/UNISIST Conference report : International Conference on National and Regional Planning for Scientific and Technological Information Systems and Services for development in the Arab countries, April 1976, Tunis.
- M. Miled : Approche méthodologique pour l'étude des besoins des ingénieurs - Séminaire sur l'information industrielle (IDCAS/UNIDO, Rabat, October 1977).

## WFEO|FMOI



- W. Pirog, Study on Engineering Information Needs - WFEO/CEI, Tunis, March 1979.
- Robert Bezilla, What we know about the Information Needs of Engineers (Paper submitted to : Engineering Index, Inc. - December 1978).
- K. Willenbrock, Rapport intermédiaire du groupe de travail sur les besoins des utilisateurs, Commission Information de l'Ingénieur (traduit de l'anglais).
- L.D. Eicher and A. David, Determining Engineer's needs for Scientific and Technical Information.
- VDI - WFEO/CEI, Utilisation and sources of Engineering Data, Rapport - 46 p. - 1975 - VDI ed.
- Recommendations to UNESCO - UNISIST - Note CEI/FMOI, Appendix B. EI (75) ML.
- Note d'un groupe de membres de la commission concernant le rapport IATFIS/XG - 1/1, du 16/4/76.
- Note CEI/FMOI EI (76) du 30/4/76.
- CEI/FMOI - Rapports du Symposium international sur l'Information technique et ses utilisateurs - Sofia (Bulgarie), June 1977 - 1 vol. 135p - ed. 1978, Conseil des Unions Scientifiques Bulgares.
- P. Lazar, Analyse and trends of Information Ressources development and their Managerial Aspects, Address delivered at the second UNISIST meeting on the planning and implementing of National Information Activities in Science and Technology, Frankfurt 26-30 septembre. 1977.
- Ducas, David, Reinhard, L'ingénieur et l'information, 1 vol. 158p - 1975, AMET, ed. Paris.
- CEIM, Projet de création d'une banque maghrébine d'information industrielle. 3 vol. - 1977, Rapport interne du CEIM à Tanger.
- Etablissement d'une banque d'information industrielle et technologique, Rapport du Directeur Exécutif de l'UNIDO - Document UNIDO ID/B/183 du 12/4/1977.
- A. David, Barrières au transfert efficace de l'information pour les besoins de l'industrie - Communication à la Conférence : An Engineering Information in Developing Countries - Cairo 22-26 April 1974.
- K. Willenbrock, Position paper on Transfer of Technological Information, Adresse à l'Assemblée Générale de la FMOI, Tunis, 1977.



INTERNATIONAL CONFERENCE ON NATIONAL AND REGIONAL PLANNING  
FOR SCIENTIFIC AND TECHNOLOGICAL INFORMATION SYSTEMS AND  
SERVICES FOR DEVELOPMENT IN THE ARAB COUNTRIES - TUNIS 1976

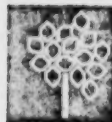
---

CONFERENCE RECOMMENDATIONS

The following are the recommendations of the Conference :

NATIONAL SCIENTIFIC AND TECHNOLOGICAL INFORMATION POLICY

1. There is a need to formulate a national scientific and technological information (STI) policy, as an integral part of the country's science and technology policy and in accordance with the aims and aspirations of its national development plan. Steps should be taken without delay by each country to define the content of such a policy and its terms of reference on a national level.
2. As a prerequisite for gradual development of co-operation in STI between Arab countries, the building up and strengthening of national STI infrastructure is urged, in particular the establishment of national focal points for the co-ordination of national STI activities and a referral point for developing regional co-operation.
3. It is also recommended that existing information structures be strengthened by providing them with competent staff and adequate facilities.
4. There is the need for co-ordination of the existing information activities in the same country, and amongst the Arab countries. The co-ordination should be confined to policy matters that help to prevent duplication of effort and facilitate the active participation in international programmes and systems.



### NATIONAL SYSTEMS AND SERVICES

5. Recognizing the need for active interaction between users and suppliers of STI :
  - a) information transfer mechanisms forming an integral part of the national information infrastructure should be developed and extended beyond the transfer of documents as well as bibliographic and numerical data to include patent and licence information services, advisory services, extension services, person-to-person communication, demonstrations, exhibitions, on-the-job training, open houses, etc...;
  - b) information units should be established in government bodies, universities, research institutes, technical firms and other institutions, involved in science and technology with the task to stimulate actual and prospective users of information within these organizations in using information services and to serve as a link between the users and the external STI services. These local (institutional) information units should form part of the national information infrastructure and should be integrated with the national mechanism for STI.
6. National inventories of STI resources (including manpower resources such as STI personnel, scientific and professional societies, subject specialists, translators and specialists capable and willing to undertake translations) should be carried out and systematically updated with the aim of :
  - a) providing data necessary for the planning of the development of STI transfer mechanisms both on national and local (institutional) level ;
  - b) making these resources better known to the actual and prospective users ;
  - c) ensuring better utilization of these resources.
7. The development of STI transfer mechanisms should be planned and based on the realistic evaluation of both national and local needs for STI as well as of available and planned resources making the widest possible use of existing structures and services. New projects should, in general, be started on a pilot or experimental basis whereby emphasis should be laid upon STI research and development projects, and feasibility studies aiming at inventing and introducing new STI handling systems, methods and techniques compatible with the Arab cultural and technological environment.
8. Regional STI surveys, inventories and feasibility studies should be encouraged and supported by providing access for the regional organizations involved to national data or surveys, inventories and feasibility studies.



9. Owing to the linguistic diversity of STI sources and materials, national translation centres should be established in the framework of the national information focal points or national information centres to facilitate the transfer of non-Arabic scientific and technological information to Arab scientists and engineers. In order to use available human and material resources most effectively, national registers and inventories of translations and translators as well as national clearing-houses of translations should be established and maintained in the national translation centres. Consolidated regional registers of translations and translators should be envisaged as well as the establishment of a regional translation centre with the aim of supporting and supplementing national translation activities in specific subject fields and languages.
10. Recognizing the popularity of mass media of communication and their high information potential, radio, television, important journals and newspapers, as well as scientific and technical films should be systematically used to deliver STI.
11. It is recommended that national bibliographic control be extended to non-published documents such as research reports, studies, development project descriptions, etc... prepared in government bodies, public and private institutions, etc...
12. In order to allow the STI systems to serve efficiently to the development of Arab countries, it is recommended that :
  - a) these systems should be designed and developed according to the needs of those concerned with scientific and technical information and according to the objectives of the national plan ;
  - b) representatives of the users' bodies should participate in the improvement and development of these means ;
13. Scientific and professional societies should take specific steps to become more actively involved in national and local (institutional) STI activities, both as users and producers of information. Specific steps might include increased publication activities in fields of high importance to national development objectives, and in particular for different levels of user requirements (e.g. for technicians, or for on-the-job training), as well as co-operation with information centres and other competent organizations in the training of information users, registering subject specialists and translators, etc...
14. Scientific and professional societies should encourage and help Arab scientists and engineers to make the results of their work more widely known through publications and modern information dissemination techniques.

REGIONAL ACTIVITIES

15. In order for the Arab region to have access to non-Arab literature, it is recommended that a regional translation referral service was established (see recommendation 9). Developmental work in the field of automatic translation should be carried on at the regional level.
16. Arab countries which have reached a reasonable stage of development can help other less developed Arab countries, to establish STI systems. For this purpose, the Arab League organizations should elaborate a complete plan of action.
17. All measures should be taken to organize collaboration in all of its forms among the Arab states and between the Arab states and other countries in the integral framework of the regional aims to solve the problem encountered in the information field and to ensure the free exchange of scientific and technological information on a not-for-profit basis. Competent international organizations are requested to provide advice and assistance for these purposes.
18. Noting that patent information should be taken into account as an integral part of STI, it is recommended that a feasibility study for the establishment of a regional patent information and documentation centre should be carried out.